PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

Improvements in or relating to the Examination of Transparent Solid Materials

We, THE TRIPLEX SAFETY GLASS COMPANY LIMITED, a British Company, of 1, Albemarle Street, Piccadilly, London, W.1, ALLAN COLEY WAINE, a British Subject, and FAZUL DIN, a British Subject, both of Triplex Works, Eckersall Road, King's Norton, Birmingham, do hereby declare the nature of this invention to be as follows :—

This invention is for improvements in or relating to the examination of transparent solid materials and has particular reference to the examination of sheets or blocks of such material.

It is often difficult to determine by inspection if a transparent material such as glass is homogeneous or is built up of a series of laminations. In certain cases it is desirable to obtain this information readily, as for example in determining whether a windscreen of a motor-car is made of laminated glass.

It is one object of the present invention to provide a method whereby this information may be obtained by a simple test and it is a further object of the invention to provide simple but robust apparatus for carrying out the examination.

The present invention accordingly comprises a method of examining a sheet or block of transparent material for homogeneity which comprises directing a beam of light through a surface of the material at an angle inclined to the normal and viewing the light which emerges from the said surface after reflection within the material.

When the sheet or block which is examined consists e.g. of two glass sheets and an interposed layer of strengthening material, such as cellulose acetate or a synthetic resin, reflection takes place at each surface of the interlayer and at the two glass surfaces and the emergent light beam is seen to consist of four images. The images from the two surfaces of the interlayer may be so close together as to appear twinned.

The beam must approach the sheet or block of transparent material at as large an angle of incidence as possible in order that separation of the various images may take place and in order that the angle of incidence may be a maximum the incident and emergent light may be passed through a transparent block or prism which is maintained in optical contact with the material to be examined by means of an interposed film of a liquid whose refractive index is of the same order as that of the block. When the transparent block and the material to be examined consist of glass the liquid employed between the transparent block and the material to be examined may consist of di-methyl phthalate, ethyl salicylate or liquid paraffin. In the absence of a prism, the angle of incidence upon the second surface (in the case of a composite material) cannot exceed the critical angle between the material of which the first layer is made and air.

The underside of the transparent material to be examined may be coated with a coloured transparent lacquer in order to absorb a large proportion of light which is reflected from the lower inside surface of the glass. The image from this surface is far brighter than any of the others and dazzles the observer if it is not reduced in brilliance. A black enamel may be substituted for the coloured enamel but in the latter case the light image reflected from that surface is coloured and hence distinguishable from the light images from the other surfaces.

The invention further includes apparatus for carrying out the method described above which comprises means for maintaining a source of light in such relation to the transparent material to be examined that a beam of light is passed into the material at an angle inclined to the normal and means for viewing the emergent light.

The source of illumination and the viewing means may conveniently be arranged so that the angles they make with the surface of the material to be examined may be adjusted.

The incident beam of light is preferably small and may consist of parallel rays and for this purpose the source of light may be provided with a variable slit and lens system.

[*Price* 1/-]

One convenient form of apparatus embodies a rhomboidal prism, for example a prism having an angle of 60° and such an arrangement enables the test to be carried out with minimum adjustment of the components of the apparatus. In employing such apparatus in the examination of a sheet or block of glass the prism is maintained in optical contact with the surface of the material to be examined by means of a film of di-methyl phthalate, ethyl salicylate or liquid paraffin. The incident beam of light is passed into that face of the prism inclined at an acute angle to the surface of the material to be examined and the emergent beam is viewed (after internal reflection at the inclined face of the prism adjacent to the obtuse angle) in a general direction normal to the surface of the material. It is desirable that the incident beam should pass through the inclined face of the prism normal to that face in order that the amount of light lost by reflection and refraction may be reduced to a minimum.

The light beam may consist of monochromatic light if colouring of the emergent beam by refraction is to be prevented.

The emergent beam may be projected into a viewing tube (which may be provided with a suitable lens system) or it may be projected upon a translucent screen for example a ground glass plate. Provision may be made for altering the angle at which the incident beam reaches the prism in order that the images may be brought into the centre of the field of view in the viewing tube irrespective of the refractive index of the material being tested.

Following is a description by way of example of one form of apparatus constructed in accordance with the present invention and adopted to test glass, say up to $\frac{1}{4}$ in. in thickness.

An L-shaped frame has mounted in one of its limbs a source of illumination consisting of an electric lamp in a case, the lower end of which is provided with an adjustable slit and lens system for rendering the beam parallel. The other limb of the frame carries a viewing tube which may be fitted with a ground glass screen. Both the source of light and the viewing tube may be adjusted and clamped by means of slots in the frame and thumb screws. The frame also holds a rhomboidal glass prism having a 60° angle, the prism having a base 2 in. by $\frac{3}{4}$ in. and a height of 1 in. A larger prism will be required if thicker sheets are to be examined. The prism is arranged so that its base is parallel to the horizontal limb of the frame and projects somewhat beyond the edge of the frame and with that inclined face which makes an acute angle with the exposed base of the prism normal to the source of illumination. The viewing tube is arranged normal to the upper face of the prism.

The examination of a sheet of glass is carried out by placing on the surface of the glass two or three drops of liquid whose refractive index does not lie too far from that of glass, e.g. di-methyl phthalate, ethyl salicylate or liquid paraffin. A patch of coloured transparent lacquer is applied to the opposite face of the sheet and the lamp adjusted to project a parallel beam of light normally through the inclined face of the prism and thence on to the patch of lacquer. When the sheet under examination consists of two or more laminations or when it is non-homogeneous due to the presence of seed or cord in the glass, the emergent beam exhibits more than two images. Thus, in the case of safety glass consisting of two sheets of glass with an interposed strengthening layer, the emergent beam consists of one image from the upper glass surface, another image from the bottom glass surface, (coloured by the lacquer) and two intermediate images, which may be so close together as to appear twinned, one from the upper face of the interlayer and the other from the lower face.

The emergent beam after leaving the sheet under examination is internally reflected at the inclined face of the prism opposite to that through which the light entered and thence passes through the upper face of the prism to the viewing tube.

It will be understood that the present invention may be employed not only for the examination of laminated glass but for the examination of composite films or of transparent synthetic material.

Dated this 24th day of January, 1938.

BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London,
E.C.1,
Chartered Patent Agents.

COMPLETE SPECIFICATION

Improvements in or relating to the Examination of Transparent Solid Materials

We, THE TRIPLEX SAFETY GLASS COMPANY LIMITED, a British Company, of 1, Albemarle Street, Piccadilly, London, W.1, ALLAN COLEY WAINE, a British Subject, and FAZUL DIN, a British Subject, both of Triplex Works, Eckersall Road, King's Norton, Birmingham, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

This invention is for improvements in or relating to the examination of transparent solid materials and has particular reference to the examination of sheets or blocks of such material.

It is often difficult to determine by inspection if a transparent material such as glass is homogeneous or is built up of a series of laminations. In certain cases it is desirable to obtain this information readily, as for example in determining whether a windscreen of a motor-car is made of laminated glass.

It is one object of the present invention to provide a method whereby this information may be obtained by a simple and rapid test which can be carried out without injuring the material to which it is applied and it is a further object of the invention to provide simple but robust apparatus for carrying out the examination.

The present invention accordingly comprises a method of examining a sheet or the like of transparent material for homogeneity which comprises directing a beam of light through a surface of the material at an angle inclined to the normal and viewing the light which emerges from the said surface after reflection within the material.

When the sheet or the like which is examined consists e.g. of two glass sheets and an interposed layer of strengthening material, such as cellulose acetate or a synthetic resin, reflection takes place at each surface of the interlayer and at the two outer glass surfaces and the emergent light beam is found to consist of four images. The images from the two surfaces of the interlayer may be so close together as to appear twinned.

It will be understood that this method of examination only yields positive results when the interlayer has a refractive index different from that of the outside sheets.

The beam must approach the sheet or the like of transparent material at as large an angle of incidence as possible in order that visible separation of the various images may take place and in order that the rays reflected from the block of material being tested shall have maximum intensity. In order that the angle of incidence may be a maximum the incident and emergent light may be passed through a block or prism of transparent material which is maintained in optical contact with the sheet or the like to be examined by means of an interposed film of a liquid whose refractive index is of the same order as that of the block. When the transparent block and the material to be examined consist of glass the liquid employed to secure optical contact between the two may consist of di-methyl phthalate, ethyl salicylate, liquid paraffin or mono-chlorobenzene. In the absence of a block or prism, the angle of incidence of the light beam upon the second surface (in the case of a composite material) cannot exceed the critical angle between the material of which the first layer is made and air.

The underside of the transparent sheet or the like to be examined may be coated with a coloured transparent lacquer or with a film of opaque material e.g. black paint or black gummed paper, in order to absorb a large proportion of light which is reflected from the lower inside surface of the transparent sheet. The image from this surface is far brighter than any of the others and dazzles the observer if it is not reduced in brilliance. When a coloured lacquer is used, the light image reflected from that surface is coloured and hence distinguishable from the light images from the other surfaces.

The invention further includes apparatus for carrying out the method described above which comprises means for maintaining a source of light in such relation to the transparent material to be examined that a beam of light is passed into the material at an angle inclined to the normal and means for viewing the emergent light.

The source of illumination and the viewing means may conveniently be arranged so that the angles they make with the surface of the material to be examined may be adjusted.

The incident beam of light is preferably small and may consist of parallel rays and for this purpose the source of light may be provided with a variable slit and lens system.

One convenient form of apparatus embodies a rhomboidal prism, for example a prism having an angle of 60° and such an arrangement enables the test to be carried out with minimum adjustment of the components of the apparatus. In employing such apparatus in the examination of a sheet or block of glass the prism is maintained in optical contact with the surface of the material to be examined by means of a film of di-methyl phthalate, ethyl salicylate, liquid paraffin or mono-chlorobenzene. The incident beam of light is passed into that face of the prism inclined at an acute angle to the surface of the material to be examined and the emergent beam is viewed (after internal reflection at the inclined face of the prism making an obtuse angle with the surface of the material) in a general direction normal to the surface of the material. It is desirable that the incident beam should pass through the inclined face of the prism normal to that face in order that the amount of light lost by reflection and refraction may be reduced to a minimum.

The light beam may consist of monochromatic light if colouring of the emergent beam by refraction is to be prevented.

The emergent beam may be projected into a viewing tube (which may be provided with a suitable lens system) or it may be projected upon a translucent screen for example a ground glass plate. Provision may be made for altering the angle at which the incident beam reaches the prism and for moving the source of light parallel to the face of the prism at which the light enters in order that the images may be brought into the centre of the field of view in the viewing tube irrespective of the refractive index of the material being tested.

Following is a description by way of example and with reference to the accompanying drawing of one form of apparatus constructed in accordance with the present invention and adapted to test glass, say up to $\frac{1}{4}$ inch in thickness.

In the drawing :—

Figure 1 is a side-view of the apparatus (with the side plate removed) ;

Figure 2 shows in diagrammatic form the path of the light rays in the apparatus ;

Figure 3 shows (on an enlarged scale) the appearance of the images when viewing a sheet of laminated glass, and

Figure 4 shows on the same scale as Figure 3 the appearance when viewing a homogeneous sheet of glass.

Similar reference numerals in Figures 1 and 2 refer to similar parts.

EXAMPLE.

Referring to Figure 1, casing 11 has mounted within it an electric lamp 12 the lower end of which is provided e.g. with an adjustable slit and lens system for giving a small intense beam of parallel light. The lamp is mounted on a carrier 13 which is capable of adjustment by means of the knurled screw 14 at its upper end. A rhomboidal prism 15 which has an acute angle of 60° is arranged so that the face 16 adjacent to the acute angle projects through the bottom of the casing 11 and so that the beam of light from the lamp 12 enters the face 17 of the prism at an angle which is substantially normal to that face. The prism may have a base 2 inches by $\frac{3}{4}$ inch and a height of 1 inch. A larger prism will be required if sheets thicker than say $\frac{1}{4}$ inch are to be examined. 18 is a plan sight tube (which may be provided with a translucent screen and lens system) arranged normal to the upper face 19 of the prism to direct the eye to the images of the incident light after reflection and to cut off unwanted light so that the images may be viewed readily. The tube may be made adjustable if desired. The lamp is connected through a lead 20 and switch 21 (operated by a knob on the far side of the apparatus) to a battery 22 (e.g. a standard 3 volt battery). 23 and 24 are bolts which pass through both side plates of the casing 11, pulling them together and thus holding the prism 15 in position and acting as retaining members for a spring clip (not shown) which, when the apparatus is not in use, is employed to protect the exposed face 16 of the prism 15 from damage.

The examination of a sheet of glass is carried out by taking approximately two square inches of black gummed paper, wetting it thoroughly by immersing it completely in water and placing it on one surface of the sheet of glass making sure that there are no bubbles of air between the glass and the paper. There are placed on the surface of the sheet of glass immediately opposite to the paper two or three drops of a liquid whose refractive index does not lie too far from that of glass, e.g. di-methyl phthalate, ethyl salicylate, liquid paraffin or mono-chlorobenzene and the lower face of the prism is brought into contact with the liquid so as to form a uniform film of liquid between the prism and the glass surface (as in Figure 2).

When the test is to be carried out on the windscreen of a motor car it is normally more convenient to apply the gummed paper to that surface of the screen facing the inside of the car and after placing the prism in position on the opposite surface of the screen to allow several drops of the liquid used for establishing optical contact between the prism and the surface of the glass to flow between the contacting surfaces.

The light is switched on and the position of the lamp adjusted by turning the knurled screw 14 until all the reflected images (as seen down the sight tube 18) lie well within the field of vision. On looking down the sight tube, spots of light are seen against a dark background. When the sheet under examination consists of two or more laminations or when it is non-homogeneous due to the presence of seed or cord in the glass, the emergent beam exhibits more than two images. Thus, in the case of safety glass consisting of two sheets of glass with an interposed strengthening layer, (as shown in Figure 2) the emergent beam consists of one image 25 from the upper glass surface 26 (of Figure 2), another image 27 from the bottom glass surface 28 and two intermediate images 29 and 30, which may be so close together as to appear twinned, one (29) from the upper face of the interlayer and the other (30) from the lower face.

The emergent beam after leaving the sheet under examination is internally reflected at the inclined face of the prism opposite to that through which the light entered and thence passes through the upper face 19 of the prism to the sight tube 18.

When plain glass (or toughened glass) is examined the centre twin image (29, 30) is absent and only two spots 25 and 27 can be seen as shown in Figure 4.

The spots of light are not of uniform intensity since the filament of the electric lamp forms a bright image running across each of the spots.

It will be understood that the present invention may be employed not only for the examination of laminated glass but for the examination of composite films or of transparent synthetic material.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is :—

1. A method of examining a sheet or the like of transparent material for homogeneity throughout its thickness which comprises directing a beam of light through a surface of the material at an angle inclined to the normal and viewing the light which emerges from the said surface after reflection within the material.

2. A method as claimed in claim 1 wherein the incident and emergent light is passed through a block or prism which is maintained in optical contact with the material to be examined by means of an interposed film of a liquid whose refractive index is of the same order as that of the block.

3. A method as claimed in claim 2 wherein the transparent block or prism consists of glass and wherein the liquid employed to secure optical contact between the block or prism and the material to be examined consists of dimethyl phthalate, ethyl salicylate, liquid paraffin or monochlorobenzene.

4. A method as claimed in any one of the preceding claims wherein the underside of the transparent sheet or the like to be examined is coated with a substance which reduces the intensity of the light reflected from the lower inside surface of the said sheet.

5. A method as claimed in Claim 4 wherein the substance with which the underside of the transparent sheet or the like is coated consists of a film of opaque material, e.g. of paint or black paper.

6. Apparatus for carrying out the method claimed in any one of the preceding claims which comprises means for maintaining a source of light in such relation to the transparent material to be examined that a beam of light is passed into the material at an angle inclined to the normal and means for viewing the emergent light.

7. Apparatus as claimed in Claim 6 wherein the source of light and the viewing means are adjustably mounted.

8. Apparatus as claimed in claim 6 or claim 7 wherein the source of light is provided with a variable slit and lens system for rendering the incident beam of light parallel.

9. Apparatus as claimed in any one of the preceding claims 6 to 8 wherein the source of light and the viewing means are employed in conjunction with a rhomboidal prism.

10. Apparatus as claimed in claim 9 wherein the rhomboidal prism has an angle of 60°.

11. Apparatus as claimed in any one of claims 6 to 10 wherein the incident beam of light enters the rhomboidal prism at an angle normal to the face of the prism which is at an acute angle to the surface of the material to be examined.

12. Apparatus as claimed in any one of claims 6 to 11 wherein the emergent light is projected upon a translucent screen e.g. a ground glass screen.

13. Apparatus for carrying out the method claimed in any one of claims 1 to 5 substantially as described in the specific example hereinbefore set forth or with reference to the accompanying drawing.

Dated this 23rd day of January, 1939.

BOULT, WADE & TENNANT,
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E.C.1,
Chartered Patent Agents.

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[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

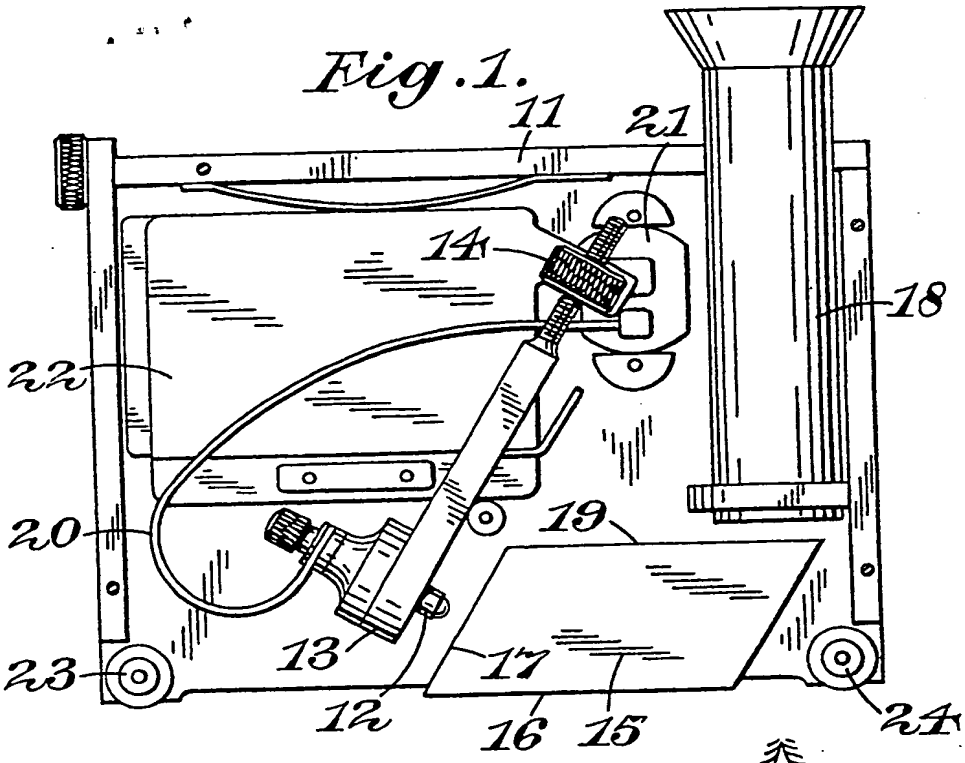

Fig. 3.

Fig. 4.

Fig. 2.

Malby & Sons, Photo-Litho.